Case Study: Chena Hot Springs

At the end of Chena Hot Springs Road, sixty miles northeast of Fairbanks, stands a greenhouse that may represent a model for communities across Alaska as they consider local food production. Chena Fresh, a 6,000-square foot, hydroponic greenhouse, makes use of renewable energy and provides Chena Hot Springs Resort with a year-round supply of fresh produce.

What sets the Chena Fresh greenhouse apart from others in the state, if not the world, is its energy efficient design. Power and heating needs for the greenhouse are met by the hot springs themselves. A geothermal power plant supplies the 62 kilowatts needed to operate the lights (48 High-Intensity Discharge lights) and other electrical equipment for up to 16 hours per day. The geothermal resource also supplies the 500,000 BTUs per hour required to keep the structure warm throughout the winter. This saves about 75 gallons of fuel oil every day.

While not every community in Alaska has a geothermal resource, the Chena Fresh greenhouse shows how efficient use of local resources can help a community take steps toward self-sufficiency. A wood-fired heating system or the use of recovered heat from a village power plant may enable a community to supply its own fresh produce economically.

For more information, please see: www.chenafresh.com

Greenhouse at Chena Hot Springs. Photos courtesy of Gwen Holdmann.

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Greenhouse ENERGY

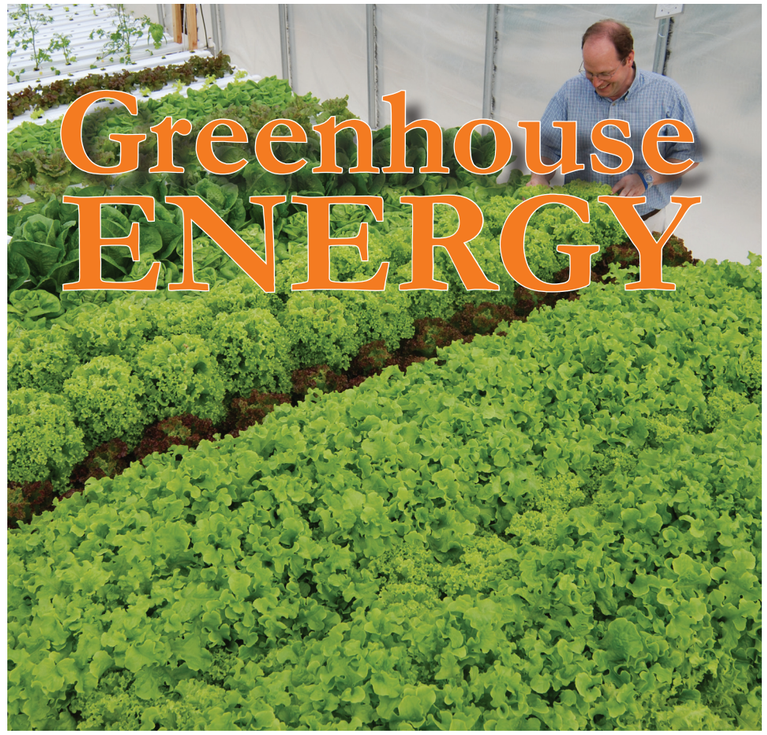


Photo courtesy of Edwin Remsberg.

One of the most important factors in a successful community greenhouse is managing the electric and heating costs.

Greenhouse Energy in Alaska Communities

Today many Alaska communities are interested in greenhouses and local food production. This is especially true in rural Alaska where the average cost of food can be up to five times higher than in urban areas. A community greenhouse can supply residents with fresh, nutritious, affordable produce while keeping money in the local economy and supporting employment opportunities.

One of the most important factors in a successful community greenhouse, whether in urban or rural Alaska, is managing the electric and heating costs. Although these costs may be low in the summer, extending the growing season into the spring and fall requires both supplemental light and heat, the cost of which will affect the economics of a greenhouse.

Fortunately, there are resources available to assist communities in planning a greenhouse project and identifying the most energy efficient design.

Lettuce growing in greenhouse. Photo courtesy of Gwen Holdmann.

Tomatos growing in greenhouse. Photo courtesy of iStockphoto.

Harnessing the energy potential of Alaska's natural resources.

Oil

Gas

Geothermal

Wind

Water

Biofuels

Photo courtesy of Gwen Holdmann.

Lighting Your Greenhouse

Supplemental lighting in a greenhouse should be managed efficiently, not just for the sake of optimum plant growth but in order to minimize electric costs. Grow lights are not typically used during the summer growing season in Alaska, though some lighting may be necessary to manipulate the photoperiod (day-night ratio). Operating a greenhouse in the spring and fall, however, requires supplemental lighting. Which lighting systems you choose will depend on a number of factors, including plant varieties, light levels, and cost considerations.

High-Intensity Discharge (HID) lights, although expensive to purchase and operate, are the most commonly used lights in greenhouses due to their high quality light output and relatively long lifespan. The most popular type of HID light for greenhouses is high-pressure sodium lamps, which produce light in the optimum yellow range. HID lights are usually cycled intermittently due to their high energy consumption.

Light-emitting diode (LED) lights are efficient, low heat, long-lasting lights that are being used in greenhouses more and more. The high initial expense of the lights is offset by their long lifespan (up to 10 years) and low operating costs (up to 30% less energy consumption than other lights).

Incandescent lights are frequently used to manipulate the photoperiod. Since incandescent lights have low efficiency, generate relatively high levels of heat, and have a shorter lifespan than other lights they are not cost effective in large greenhouses.

Fluorescent lights are commonly used early in the growing season when starting plants from seed. Their low-level output makes them a poor choice for maturing and finishing plants in a greenhouse.

How much will it cost to operate lights in a greenhouse? The answer to this question depends on a number of variables, but must be considered when planning for a large greenhouse. To take a simple example, assume a 20' x 30' greenhouse in which you are growing only lettuce seedlings. You will need about 24 HID lights rated at 440 watts to provide adequate lighting for the beds. Assuming the lights supplement natural light by running for 12 hours a day, the total daily electric usage equals 126.72 kilowatts. At $.50 per kilowatt-hour, the total daily electric cost is $63.36.

Electric costs can add up quickly—especially in rural Alaska where the cost of power is particularly high—which shows why careful consideration must be given to plant varieties and lighting system options.

Information about energy values for different lighting systems and light requirements for various plant species is available in "Controlling the Greenhouse Environment," by Thomas R. Jahns and Jeff Smeenk, available from the UAF Cooperative Extension Service at: www.uaf.edu/ces.

Heating Your Greenhouse

A heating system in a greenhouse can extend the growing season into the spring and fall, and can even maximize summer production for certain plants by maintaining ambient temperature throughout the night. But as with electric costs, consideration should be given to heating system efficiency so as to keep operating costs as low as possible. This is true regardless of the type of greenhouse and heat loss from the structure.

Wood heating is a simple, cost-effective method for heating a greenhouse. Drawbacks include difficulty in regulating temperature, especially during nighttime, and the regular feeding of the woodstove that is required.

Recovered heat from diesel generators in a community's power plant may provide a stable, cost-effective source of heat for a greenhouse. As a generator burns diesel fuel, most of the energy in that fuel is lost in the form of radiated heat and exhaust. Capturing that heat by means of a water jacket produces a resource—hot water—that can be delivered to a nearby greenhouse and used to heat the structure. With power plants running round-the-clock, communities can make use of this existing resource that may have no other uses (i.e., space heating in adjacent buildings) in the spring-summer-fall timeframe when the greenhouse is operating.

Hot-water heaters can provide effective radiant or baseboard heating, although the fuel/electric costs may be too high to make the system cost-effective, especially in rural areas.

Electric heaters may be useful in small spaces or as a back-up system, but the high operating costs makes them impractical for most large greenhouses.

Solar heating, in the form of heat capture by storage devices inside a greenhouse, provides a low-cost method for maintaining ambient temperature. Heat can be effectively captured and radiated over a relatively long duration by rocks, concrete blocks, and containers filled with water.

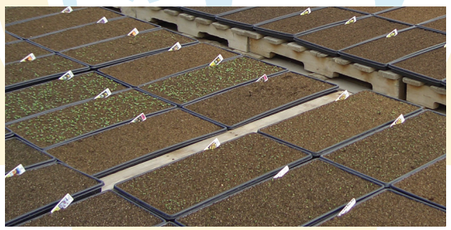
Other renewable energy resources, including solar, wind, and geothermal, may have potential for greenhouse applications. Manley Hot Springs and Chena Hot Springs (see back page) are two communities where greenhouses make use of a geothermal resource.

How much heat is required in a greenhouse? Much like the question about lights and electric costs, the answer to this question depends on many variables. The outside temperature, heat loss from the structure, plant varieties, and many other factors will affect the heating load of a greenhouse. As a general rule, the heating load is equal to the outside area of the greenhouse (i.e., walls and roof) in square feet multiplied by the heat loss factor of the outside glazing (i.e., 1.2 for a single layer of glass or plastic) multiplied by the difference in outside vs. inside temperature in degrees F.

To illustrate the point, take the same 20' x 30', single-walled glass greenhouse in the lighting example above. When the outside temperature is 30 degrees F, maintaining an inside temperature of 60 degrees F will require approximately 120 BTUs per square foot per hour, for a total heat load of 72,000 BTU/hour. Heating the greenhouse for 24 hours under those conditions would require about 12 gallons of heating oil, 19 gallons of propane, or 247 pounds of dry wood (approximately 1/10 cord).

A heating system in the greenhouse can extend the growing season

Lettuce production in greenhouse. Photo courtesy of Edwin Remsberg.



Seed starting. Photo courtesy of Gwen Holdmann.

Tomato production in controlled greenhouse. Photo courtesy of Gwen Holdmann.